

Air Force Institute of Technology



U.S. AIR FORCE

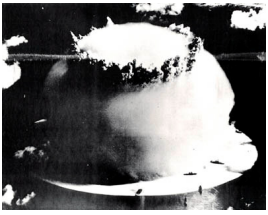
Air Blast

NENG 631

LTC David LaGraffe



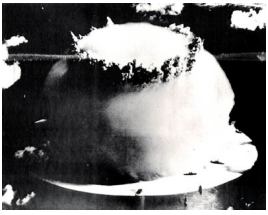
Educating the World's Best Air Force



Structural Response to Overpressure and Gust

- Internal structure provides a restoring force, $F_{\text{restoring}}$
 - Elastic deformation limit – Hooke's Law applies: $F = -kx$
 - Plastic deformation limit
 - Failure limit
- Sure safe = displacement less than elastic limit
- Sure kill = displacement exceeds failure limit
- $F_{\text{net}} = F_{\text{applied}} - F_{\text{restoring}}$

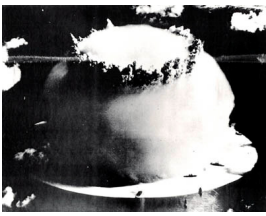
$$ma = m \frac{d^2x}{dt^2} = [\Delta p(t) + C_d q(t)] A - kx$$



General Solution





$$x(t) = \int \frac{1}{m\omega} [\Delta p(t') + C_d q(t')] A \sin[\omega(t - t')] dt'$$

$$\omega = \sqrt{\frac{k}{m}}$$




















Drag Coefficients


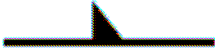

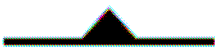
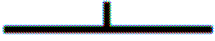
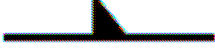
Bodies of Revolution

Sphere		C_d 0.10		Circular Plate		C_d 1.17
Half Sphere		0.42		60° Cone		0.5
Half Sphere		1.42				

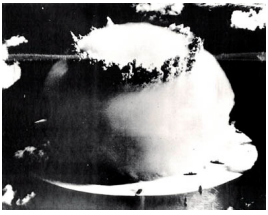
Structural Shapes (Long members without end effects)

C_d	C_d	C_d
 2.0	 1.8	 1.55
 2.0	 1.45	 2.0
 1.65	 2.2	 2.0
 2.05	 1.2	 1.55
 2.0	 2.3	 1.05
	 1.2	 1.54

Protuberances (Without end effects)

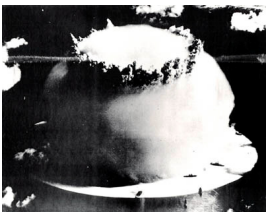
C_d	C_d
 0.80	 1.03
 1.20	 1.00
 1.25	 1.28

Flow direction: from left to right. For high Reynolds numbers.



Example

- Building of side area = 162.6 m^2 (1750 ft^2)
- mass = $4.545 \times 10^5 \text{ kg}$ ($1 \times 10^6 \text{ lb}$)
- natural frequency, $\omega = 5 \text{ s}^{-1}$
- Exposed 1 MT air burst at 7,500 ft and 14,300 ft from ground zero
- Determine p , q , C_d
 - $p = 10 \text{ psi}$
 - $q = 2.2 \text{ psi}$
 - $t_p = 2.6 \text{ sec}$
 - $t_q = 3.6 \text{ sec}$
- Solve numerically



Solution

